PATENT CLAIMS

1. Optical network element for use in a node of an optical network including a plurality of nodes which are interconnected so as to be capable of carrying traffic between selected nodes, comprising of

1.1 a local network management system (11) including means for building up a supervisory connection (10.1) between the network element and at least a network element of a further node of the optical network;
characterized in that

1.2 the local network management system (11) is installed to support an arbitrary network topology and to build up a supervisory connection (10.1) to at least one predetermined other node of the network so as the network element could be integrated in an optical network with arbitrary topology.

2. Optical network element according to claim 1, characterized in that the local network management system (11) provides self healing of the supervisory connection (10.1) in the case of an impairment of the supervisory connection (10.1).

3. Optical network element according to claims 1 or 2, characterized in that the local network management system (11) comprises of a software module which acts as a node manager (100) and includes one or more of the following software agents:

- start-up manager (101)
- process, thread and session manager (102)
- supervisory channel manager (103)
- hardware devices manager (104)
- status, fault, and events monitor (105)
- database system manager (106)
- user interfaces, especially GUI, console, TL1 (107)

system resources and functions manager (108)

4. Optical network element according to one of the claims 1 to 3, characterized in that the local network management system (11) has the flexibility to be configured by standard software protocols, especially by OSPF and/or MPLS.

5. Optical network element according to one of the claims 1 to 4, characterized in that the local network management system (11) is built up to automatically discover network elements of adjacent network nodes and to exchange Link State Advertisement with the same.

6. Optical network element according to one of claims 1 to 5, characterized in that the network element comprises of

6.1 at least one back-plane with a plurality of electrical transmission lines running across the back-plane and a plurality of electrical terminals connected to the transmission lines;

6.2 a plurality of line-card slices having electrical terminals, each line-card slice being attached to the back-plane directly or in the form of a plug-in module such, that the electrical terminals of the line-card slice are electrically connected to selected ones of the terminals of the back-plane, with

6.2.1 at least one of the line-card slices comprising of at least one optical receiver for receiving of optical signals from the network and at least one opto-electrical converter integrated in or optically connected to the optical receiver with electrical terminals and

6.2.2 at least one of the line-card slices comprising of at least one optical transmitter for transmitting of optical signals to the network and at least one electro-optical converter integrated in or optically connected to the optical transmitter with electrical terminals;

6.3 various or all of the said electrical terminals are implemented in form of switch terminals that provide selected and reconfigurable electrical

interconnections among various of the at least one receiver, transmitter and/or converter. from one single line-card slice or from different ones using electrical switches or at least one electrical cross-connect.

6.4 at least a supervisory card plugged to the back-plane for transmitting and/or processing of supervisory signals; whereby

6.5 the supervisory card is electrically connected via the electrical transmission lines of the back-plane to a predetermined line-card slice directly or through a cross-connect.

7. Optical network element according to claim 6, characterized in that the network element further comprises of a node PC, especially in form of an plug-in card, plugged to the back-plane, which provides and/or receives an electrical supervisory signal, that is transmitted to or from the supervisory card.

8. Optical network element according to claims 6 or 7, characterized in that the supervisory card transmits and/or receives an electrical supervisory signal, that is received and/or transmitted by a node PC connected to the network as a standalone computer sub-system.

9. Optical network element according to one or more of the preceding claims, characterized in that the supervisory connection (10.1) provides at least a part of an in-band supervisory data by using electrical multiplexing and demultiplexing of supervisory data with client's data, carried by the optical network.

10. Optical network element according to one or more of the preceding claims, characterized in that the supervisory connection (10.1) provides at least a part of an out-of-band supervisory data multiplexed onto or demultiplexed from one or more optical fiber links of the optical network by means of a WDM coupler or filter.

11. Optical network including a plurality of nodes which are interconnected so as to be capable of carrying traffic between selected nodes, comprising of a plurality of network elements according to one of the preceding claims and further comprising:

11.1 a network management system carried out by one or more of the local management systems (11) of the network elements;

11.2 supervisory connections (10.1) between predetermined network elements.

12. Optical network according to claim 11, characterized in that the network management system provides the establishment of a direct logical supervisory connection between any desired pair of nodes interconnected by a supervisory connection (10.1).

13. Optical network according to claim 12, characterized in that one or more of the logical supervisory connections are carried at least in part by means of time division multiplexing and/or statistical multiplexing over a single physical supervisory connection between a pair of nodes.

14. Optical network according to one of claims 11 to 13, characterized in that the network management system provides at least one of the following functions:

- hardware fault and/or software error detection on all supervisory connections
- auto-recovery of supervisory connections (10.1)
- fault-tolerant and/or redundant supervisory connections
- automatic discovery of nodes of the network.

15. A method of providing a supervisory network in an optical network with an arbitrary topology including a plurality of nodes which are interconnected so

as to be capable of carrying traffic between selected nodes, comprising the steps of:

15.1 automatic discovery of the network topology;

15.2 establishing of supervisory connections (10.1) between predetermined nodes of the network.

16. Method according to claim 15, characterized in that each node of the network comprises of a local network management system (11), especially comprising of at least one node manager (100), whereby the local network management system (11) of each node communicates with the local network management system (11) of adjacent nodes and exchanges Link State Advertisements, such that each node discovers all of its adjacent nodes and by utilizing the exchanged Link State Advertisements a routing table is generated that is stored in one, several, or all of the nodes.

17. A method according to claim 16, characterized in that the node manager (100) of each node executes a single OSPF, whereby the OSPF in each node is configured to communicate with the node manager (100) of adjacent nodes so that the OSPF converges on the topology of the network.

18. A method according to one of claims 15 to 17, characterized in that the status of the supervisory connections is monitored, especially by OSPF, and in the event of link failure alternative routes are configured.

19. A method according to one of claims 15 to 18, characterized in that

19.1 any supervisory data carried by the optical network for use in the supervisory management layer of the network is sent in form of messages through one or several or possibly all available redundant connections from a sending end to a receiving end of the network;

19.2 each message is given a sequence number;

19.3 on the receiving end the duplicate messages are discarded and only one of the several arriving messages is passed on to the supervisory management layer.

20. A method according to one of claims 16 to 19, characterized in that the network management is carried out by a node manager (100) present in the local management systems (11) in each node or in one or more nodes of the network.

21. A method according to one of claims 15 to 20, characterized in that hardware fault and/or software error detection is carried out on all supervisory connections (10.1).

22. A method according to one of claims 15 to 21, characterized in that auto-recovery or self-healing is carried out on all supervisory connections.

23. A method according to one of claims 15 to 22, comprising the further steps of:

23.1 monitoring the status of each connection by sending keep-alive messages at predetermined intervals of time between the respective interconnected nodes and by resending reply-messages on receiving of a keep-alive message;

23.2 the closing down of the connection between the respective nodes in the event that a reply-message in response to a keep-alive message is not received within a predetermined time period.

24. A method according to claim 23, further comprising the step of automatically re-establishing a new connection between the respective nodes via an alternative connection path.

25. A method according to one of claims 15 to 24, characterized in that predetermined and/or real time information concerning the network status is stored in the local network management system (11) of at least one predetermined node.